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Age, socioeconomic status, and mortality at the aggregate level

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Abstract

Study objective **– Indicators of socioeconomic status are associated with age. This study aimed to analyse the influence of the age distribution on the ranking of small areas by socioeconomic status and on the association between their socioeconomic status and standardised mortality.**

Design **– The ranking of small areas by socioeconomic status indicators (educational level, income, and unemployment) was compared with crude values and after correction for their age structure. The age and gender standardised mortality ratios (SMRs) of these areas for the age group 1–64 years was then rank correlated with both crude and age standardised measures of socioeconomic status.**

Setting **– This study used data for all (n = 22) boroughs of Amsterdam for the period 1986–91.**

Main results **– Correction of indicators of socioeconomic status for the age structure of the population hardly affects the ranking of Amsterdam boroughs by socioeconomic status. All rank correlations between crude and age standardised socioeconomic status measures are above 0·95. Rank correlations between SMR and these socioeconomic status measures also hardly change after correction for the age structure of boroughs *except for education.* Mean income per earner is the socioeconomic status indicator most strongly associated with the SMR.**

Conclusions **– This study shows that the age structure of Amsterdam boroughs has almost no influence on their ranking by socioeconomic status and a limited influence on the association between their socioeconomic status and SMR, *except for educational level.* The latter indicator has the strongest association with age. This result and theoretical considerations indicate that a correction for the age structure of the population will be more important if small areas differ little with regard to socioeconomic status, if they vary considerably in age structure, or if a given indicator of socioeconomic status shows a strong cohort effect or age association.**

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The socioeconomic status (SES) or deprivation index of small areas is often used both to distribute financial means for health and social care[1–4] and to study the association between SES and health indicators, such as mortality.[5–15] In this type of application, indicators for the SES of small areas have not until now been corrected for the age structure of the populations concerned, though some indicators are strongly associated with age. The educational level of a group, for example, is highly dependent on its age distribution because of a cohort effect in educational participation. The proportion of people with only a diploma from primary school is only 6% in the 18–24 years age group but it increases to 61% in the over 75 years age group in The Netherlands. This indicates that having only a primary school diploma is normal in the oldest cohort whereas it is an indicator of an unusual situation in the youngest one. Thus, the average SES (based among other factors on years of education) of an area is influenced by the age structure of its population, and the ranking of small areas by SES may thus be confounded by the age structure of the population.

SES ranking of small areas is used to study the relation between the SES and health of the populations of these areas. This has been done in relation to age standardised mortality, both in The Netherlands,[5,6] in the main Dutch cities,[7–11] and in parts of the United Kingdom.[12–15] The impact of the age structure of small areas on the value of SES measures can hamper these studies.

Accurate measurement of the SES of small areas is also important for public health policies. Many public health authorities give priority to areas with a low ranking on available SES indicators to reduce and compensate for socioeconomic health differences. The latter is one of the objectives of the healthy cities network[16,17] and of separate local public health authorities, for instance of the city of Amsterdam.[18] Their approach is backed by studies which show that low SES is associated with a worse health status at the individual level.[19–21] The targeting in such a policy is not meant to be partially dependent on the age structure of the areas concerned.

We therefore focus on the influence that the age structure of the populations of small areas has on the measurement of their SES. Does correction of SES for the age structure of the population concerned change the ranking of these areas and does such a correction lead to a different association between the SES and age standardised mortality of these areas? We used data on SES and mortality which are obtainable for boroughs of the city of Amsterdam, the capital of The Netherlands.

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Methods

DATA

SES is usually determined by education, occupation, and income. This follows both the current practice in epidemiology,[22] and the advice of a Dutch expert group on using the SES in relation to health differences.[23] The data on the SES of Amsterdam boroughs were collected from various sources.

Data on education were obtained from a 2·8% sample of the population aged 15–64 years in 1985. The proportion of people with only a diploma from primary school or less and the proportion of those with a diploma from a higher professional body or university education as indicators of SES were considered in separate analyses.

Data on occupation were not available at a borough level, so data on unemployment were used instead. These data concerned the proportion of the population registered as jobless at the end of 1988, the middle of the period studied.

Data on mean income per earner were based on income tax data for 1984, the latest year for which data were available.

Age specific data on all SES indicators for the entire city are presented in table 1. These show a very clear gradient in relation to age, especially for education and unemployment.

Data on deaths and on person years in relation to age in the period 1986–91 were derived from the municipal population register. We used data on the age group 1–64 years. Infant mortality was excluded because past analyses have shown that this is registered incompletely.[24] The upper age boundary was determined by examining up to which age only a negligible number of deaths occurs in nursing homes. The distribution of nursing homes and other care institutions is unequal in the different boroughs of Amsterdam, causing a migration between boroughs that is conditional on health status. For one year, 1990, additional data on the proportion of differences in mortality which could be explained by deaths occurring in these institutions were gathered. On the basis of these data the age of 65 years was used as a cut off point. Below this age only 1·7% of the variation in standardised mortality ratios (SMRs) between boroughs could be explained by deaths in institutions, as opposed to 20·8% when using the age of 75 years as a cut off point.

All data were collected at the level of the Amsterdam boroughs (n = 17), which have had separate local authorities since 1988. They consist of adjacent areas united on the basis of sociocultural homogeneity. The biggest four were subdivided further to obtain areas of approximately the same population size (n = 22; mean (SD) population during 1986–91 31 500 (7020); mean proportion below age 45 years: 0·66, range 0·41–0·80). Age specific data on income were not available for these latter subdivisions.

Table 1 Percentage of the population in relation to educational level, unemployment, and net income and age, Amsterdam

Measure of socioeconomic status	*Age group (y)*				
	16–24	*25–34*	*35–49*	*50–64*	*Total*
Highest educational level (1985):					
Primary education diploma only	10·9	12·0	21·0	35·4	20·6
Higher professional/university qualification	0·0	11·5	10·0	2·5	7·0

	Age group (y)						
	16–24	*25–39*	*40–49*	*50–54*	*55–59*	*60–64*	*Total*
Percentage unemployed and looking for work (1988)	15·4	18·3	13·4	10·6	5·5	0·0	14·4

	Age group (y)					
	16–24	*25–34*	*35–44*	*45–64*	*>65*	*Total*
Mean yearly net income in guilders/earner (1984)	13 484	21 380	26 810	28 570	20 981	22 904

Table 2 Results of a factor analysis on the ranks of crude and age standardised measures of socioeconomic status

	Crude		*Age standardised*	
Factor loadings	*Factor 1*	*Factor 2*	*Factor 1*	*Factor 2*
Education (diploma):				
Primary school only	0·32	−0·92	0·56	−0·77
Higher professional/university	0·27	0·94	0·17	0·96
Unemployment	0·98	0·13	0·98	0·13
Income	−0·97	0·16	−0·97	0·17
Eigen value	2·10	1·75	2·36	1·43
Percentage of variance	52·4	43·8	58·9	35·8

MEASURES

All SES data were used crude and standardised indirectly for age (in five-year age groups), with the total Amsterdam population in the period concerned as the standard. As an overall measure of the different SES indicators we used the first two factors from a factor analysis with varimax rotation on all crude SES measures and on all age standardised SES measures. Table 2 presents information on the structure of these factors in the 17 boroughs for which all SES data, both crude and age standardised, were available. The first factor of this analysis mainly represents income and unemployment rate (absolute value of correlation coefficients above 0·95).

Mortality data were used crude (crude mortality rates, CMRs) and indirectly standardised for age and gender (SMRs). The resulting figures for the different boroughs are given in table 3 and the SMRs separately in figure 1. Approximate 95% confidence intervals for the SMRs were computed according to Rothman.[25]

ANALYSIS

Firstly, correlation coefficients were computed between the ranks of the crude and age standardised SES measures, leading to Spearman correlation coefficients. Next the same was done for the SMR of the total population (1–64 years), with both the crude and the age standardised SES measures and the factors from the factor analysis. Finally, a stepwise, ordinary least squares regression analysis was per-

Table 3 Data per Amsterdam borough for 1986–91. Numbers of deaths and person years and crude mortality per 1000 person years and standardised mortality ratios (residents aged 1–64 y)

Borough	Deaths	Person years	Crude mortality	Standardised mortality	95% CI
Inner city:					
Centre	369	142 076	2·60	1·14	1·03,1·26
East	342	123 047	2·78	1·31	1·18,1·46
West	372	132 405	2·81	1·23	1·11,1·36
Westerpark	487	165 395	2·94	1·36	1·25,1·49
Oud-West	399	180 031	2·22	1·05	0·95,1·15
De Pijp	465	190 718	2·44	1·12	1·02,1·23
Oost	399	177 520	2·25	1·10	0·99,1·21
Zeeburg	318	128 789	2·47	1·19	1·06,1·32
Bos en Lommer	405	157 370	2·57	1·04	0·94,1·15
de Baarsjes	464	194 240	2·39	1·05	0·96,1·15
South:					
East	220	111 716	1·97	0·73	0·64,0·83
West	384	158 857	2·42	0·96	0·87,1·06
Rivierenbuurt	310	137 419	2·26	0·84	0·75,0·94
Watergraafsmeer	299	99 118	3·02	0·92	0·82,1·03
North:					
North	554	220 681	2·51	0·81	0·75,0·88
South	552	169 581	3·26	1·05	0·96,1·14
Geuzenveld Slot.	522	156 322	3·34	0·93	0·86,1·02
Osdorp	492	162 755	3·02	0·88	0·80,0·96
Slotervaart Overt.	386	129 113	2·99	0·87	0·79,0·96
Buitenveldert	240	81 230	2·95	0·71	0·63,0·81
Southeast:					
North	568	270 948	2·10	1·14	1·05,1·24
South	351	188 683	1·86	0·88	0·80,0·98
Total city	8898	3 478 008	2·56		

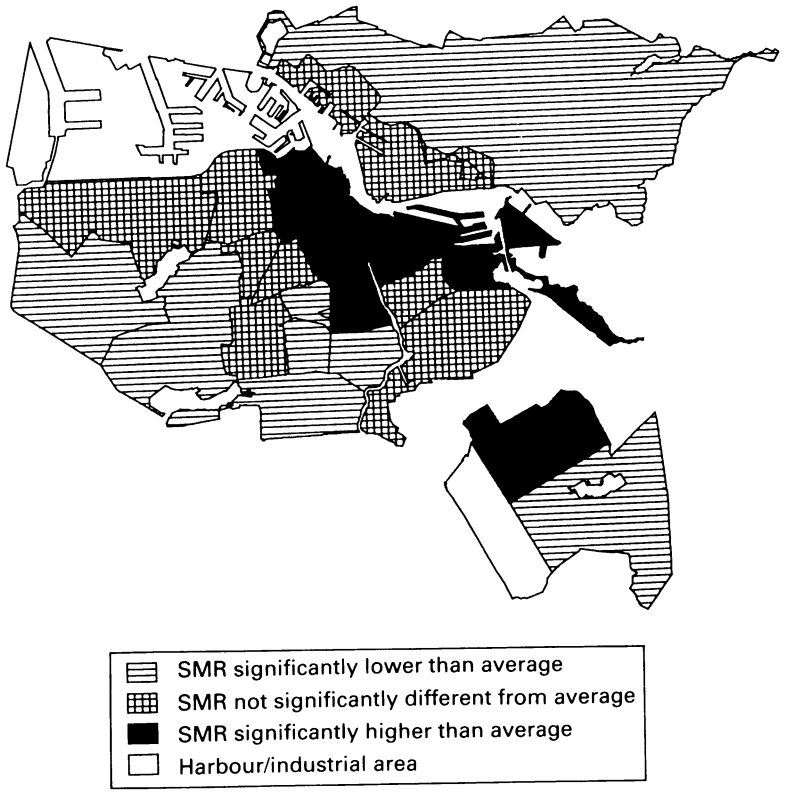

Figure 1 Distribution of standardised mortality ratios (SMR) per borough in Amsterdam, 1986–91.

Table 4 Rank correlation coefficients between crude and age standardised measures of socioeconomic status

Variable	R	p value
Education (diploma):		
Primary school only	0·95	<0·001
Higher professional university	0·99	<0·001
Unemployment	0·98	<0·001
Income	1·00*	<0·001
First factor	1·00*	<0·001
Second factor	0·99*	<0·001

* n = 17.

formed on all crude and age standardised SES measures, with and without inclusion of the respective factors. Both forward and backward stepwise procedures were used. No weights were added in this regression analysis because of the approximately equal population size of the units of analysis and because of the relatively large number of deaths in each borough. Sampling error thus formed a very limited part of the error term in the regression function.[26] All analyses were performed on ranked data. Analyses on log transformed data yielded similar results and are not therefore presented separately.

Results

ASSOCIATION BETWEEN CRUDE AND AGE STANDARDISED SES MEASURES

All Spearman rank correlation coefficients between crude and age standardised SES measures are 0·95 or above. Thus, the effect of correcting the SES indicators of boroughs for their age structure is small, despite the strong association between age and most SES indicators. In table 4 Spearman rank correlations are presented.

ASSOCIATION BETWEEN SES AND MORTALITY

All associations between SES and mortality are in the expected direction – a less favourable SES value is associated with a higher SMR. The strength of the association varies widely – it is strong for income, unemployment, and the first factor (which largely represents income and unemployment) and weak for educational level and the second factor (table 2). In the analysis of the proportion of the population with only a diploma from primary school, differences exist between crude and age standardised measures in relation to the SMR. No difference of any importance is found between the other crude and age standardised SES measures. Spearman correlation coefficients are given in table 5.

Figure 2 shows the relation between SMRs and the proportion of people with only a diploma from primary school, with and without correction for the age structure of the population of boroughs. Correction for the age

Table 5 Rank correlation coefficients between indicators of socioeconomic status and standardised mortality ratios (1–64 years) per borough of Amsterdam

Variable		R	p value
Education (diploma):			
Primary school only	Corrected	0·43	<0·05
	Uncorrected	0·23	
Higher professional/ university	Corrected	0·09	
	Uncorrected	0·17	
Unemployment	Corrected	0·85	<0·001
	Uncorrected	0·86	<0·001
Income	Corrected	−0·93*	<0·001
	Uncorrected	−0·94*	<0·001
	Uncorrected	−0·90	<0·001
First factor	Corrected	0·91*	<0·001
	Uncorrected	0·90*	<0·001
	Uncorrected	0·89	<0·001
Second factor	Corrected	−0·17*	
	Uncorrected	−0·18*	
	Uncorrected	−0·01	

* n = 17.

structure of boroughs causes most observations to centre along one diagonal, leaving three observations apart in the upper left quadrant of the plot. These three data points represent the inner city of Amsterdam. If these three outlying observations are omitted, the rank correlation coefficients of the standardised mortality with the proportion of people with only a diploma from primary education are 0·60 and 0·84 (both: $p < 0.001$), with and without correction for the age structure of the populations respectively.

REGRESSION

The only variable which is selected is income, taking into account the age standardised SES measures with and without the factors from the factor analysis. Standardised regression coefficients equate correlation coefficients in this case and are therefore not presented separately. The same variable is selected using the unstandardised SES measures.

Discussion

This study shows that the age structure of boroughs in the city of Amsterdam has a small influence on the ranking of boroughs in relation to their SES. Differences in the effects of the age structure for various SES indicators can probably be explained by variation in measures (proportions and means) and by the kind of data (sample or whole population).

The age structure of the Amsterdam boroughs also seems to have a limited influence on the association found between the SES and SMR. One SES indicator, the proportion of people with primary school education only, is an exception and shows a relatively large change after correction for the age structure of the population. This is because the proportion of people with a primary school diploma only has a stronger association with age than the other SES indicators as a result of a cohort effect in educational participation (table 1).

The limited influence of the age structure of Amsterdam boroughs on the measurement of SES seems to indicate that given SES indicators do not have to be corrected for age. Correction for the age structure of the population will be more important, however, if small areas differ little with regard to SES, if they vary considerably in age structure, or if a given SES indicator shows a strong cohort effect or age association. If areas differ sufficiently in SES, the impact of varying age structures will be less important. In all these cases both the SES ranking of areas and the association between SES and mortality can be affected by the age structure. This is illustrated by our results on primary school education which show the largest change after correction for age structure. The limited influence of the age structure of the Amsterdam boroughs on the other results can also be partly explained by rather large differences in SES and socioeconomic health in this city which were also shown by research in the 1970s and 80s.[7,8]

The use of a common factor in a wide range of indicators to measure the SES or deprivation of small areas, like the Jarman[1] or Townsend index[14] or others,[6,15] does not automatically protect against the influence of the age structure of the populations concerned, even if age dependent indicators, such as the proportion of under 5s in the Jarman index, are omitted.

Until now part of the discussion on the measurement of the SES of small areas has concentrated on the problem of cross-level bias, the "ecological fallacy",[27-31] concerning inferences from group to individual health and not on the measurement of SES as such. In this paper the problem of cross-level bias is not discussed because no inferences from group to individuals are needed. Policy makers are usually interested in the populations of small areas as a whole for priority setting in public health in order to reduce or to compensate for socioeconomic health differences. For instance, public health promotion and community development are targeted at the aggregate and not at the individual level. Thus groups are the units of analysis in this study and this makes the ecological fallacy less interesting.

In measuring the SES of small areas, ideally either SES indicators which have no association with age should be used or these should be corrected for the age structure of the popu-

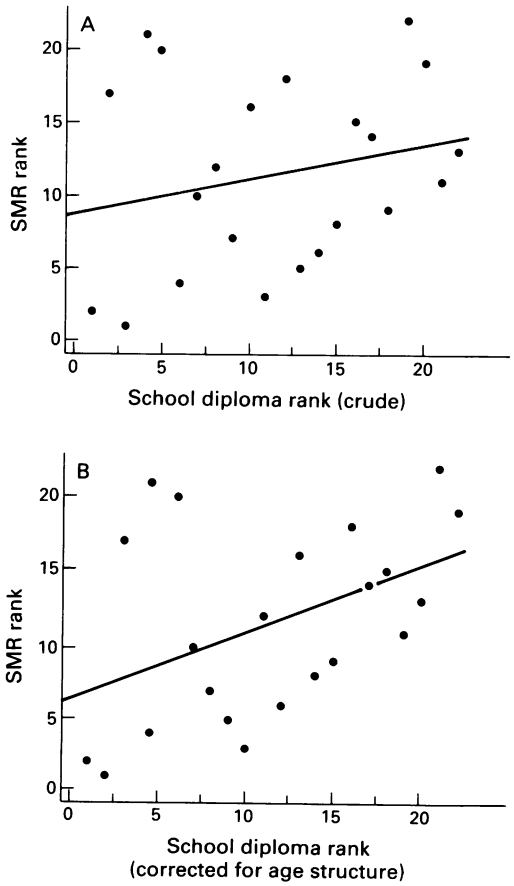

Figure 2 Plots of the ranks of boroughs according to the standardised mortality ratio (SMR) (1–64 years) in relation to their ranks in terms of the proportion of their population with only a diploma from primary school (crude and age standardised).

lations concerned. The alternative, a situation in which the populations of all areas have the same age structure, will be very rare. It is difficult to determine in advance when such a correction is important, because this also depends on the amount of variation in SES between areas. However, if policy makers think of starting a policy aimed at reducing area-bound socioeconomic health differences, then SES differences are usually visible and thus probably rather large. A correction of the SES measure for the age structure of the population is also appropriate for research on the association between SES and health indicators of small areas. SES will be measured less precisely if the age structure of the areas concerned varies at random. This lack of precision will usually lead to an underestimation of the association between SES and mortality at the aggregate level.

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